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Mars 2020 Project

Mars 2020 Entry, Descent, and Landing Verification and Validation

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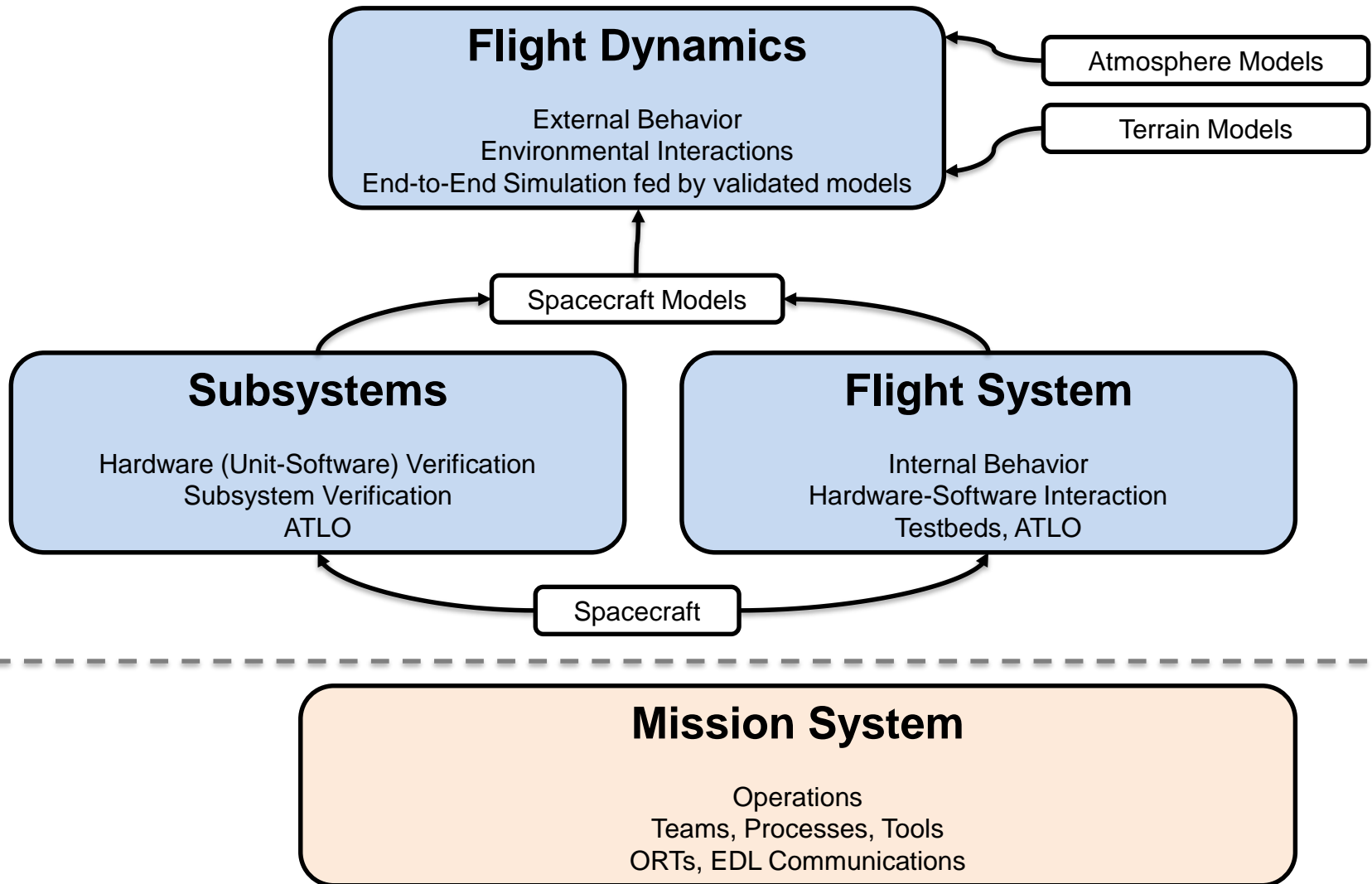
EDL V&V is Challenging



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- **EDL is very complex**
- **Cannot completely "test as you fly, fly as you test"**
- **Strive to design EDL System and EDL V&V Program together**



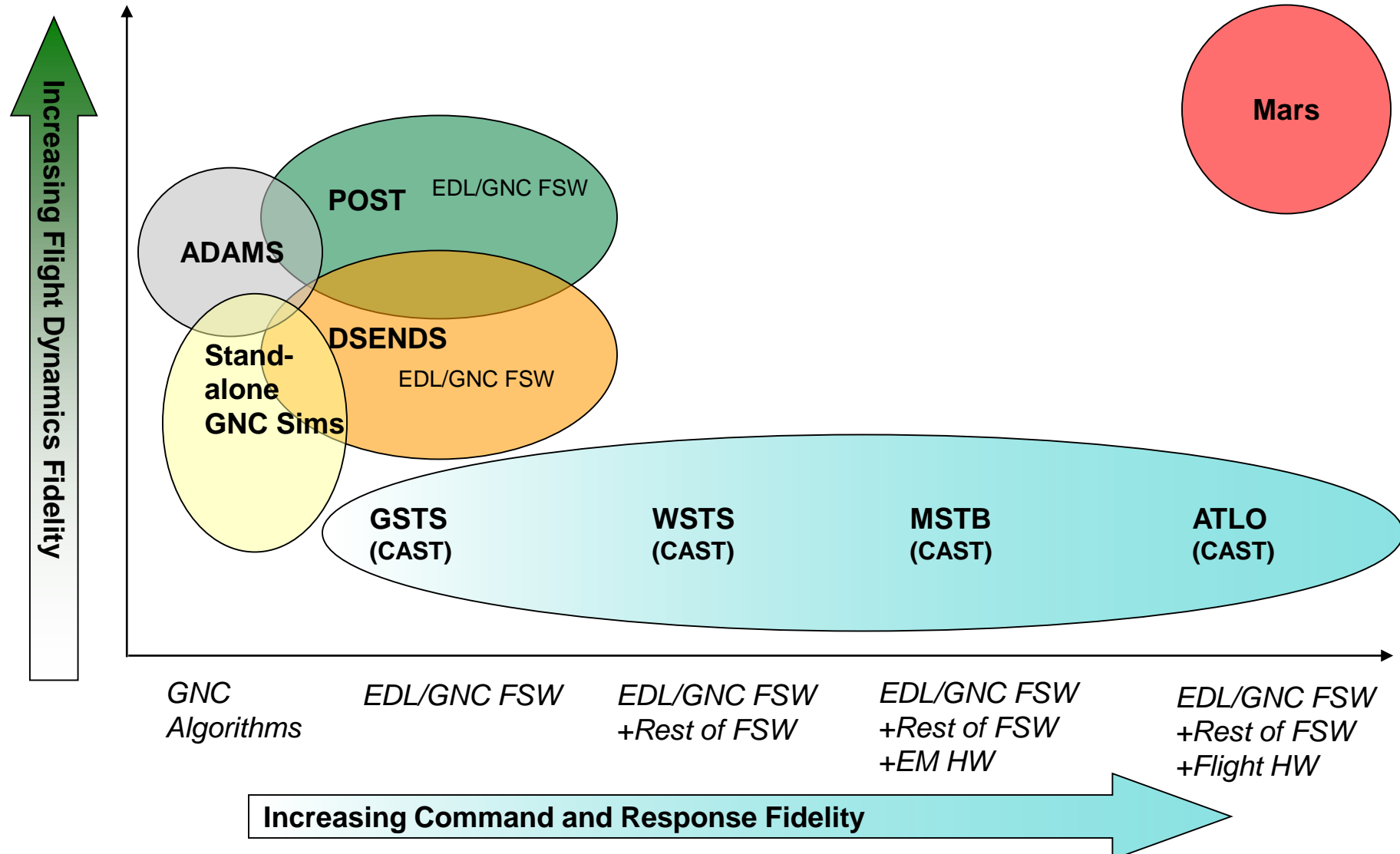
EDL V&V is very complex and having domains allow us to decompose the problem

EDL V&V Venues



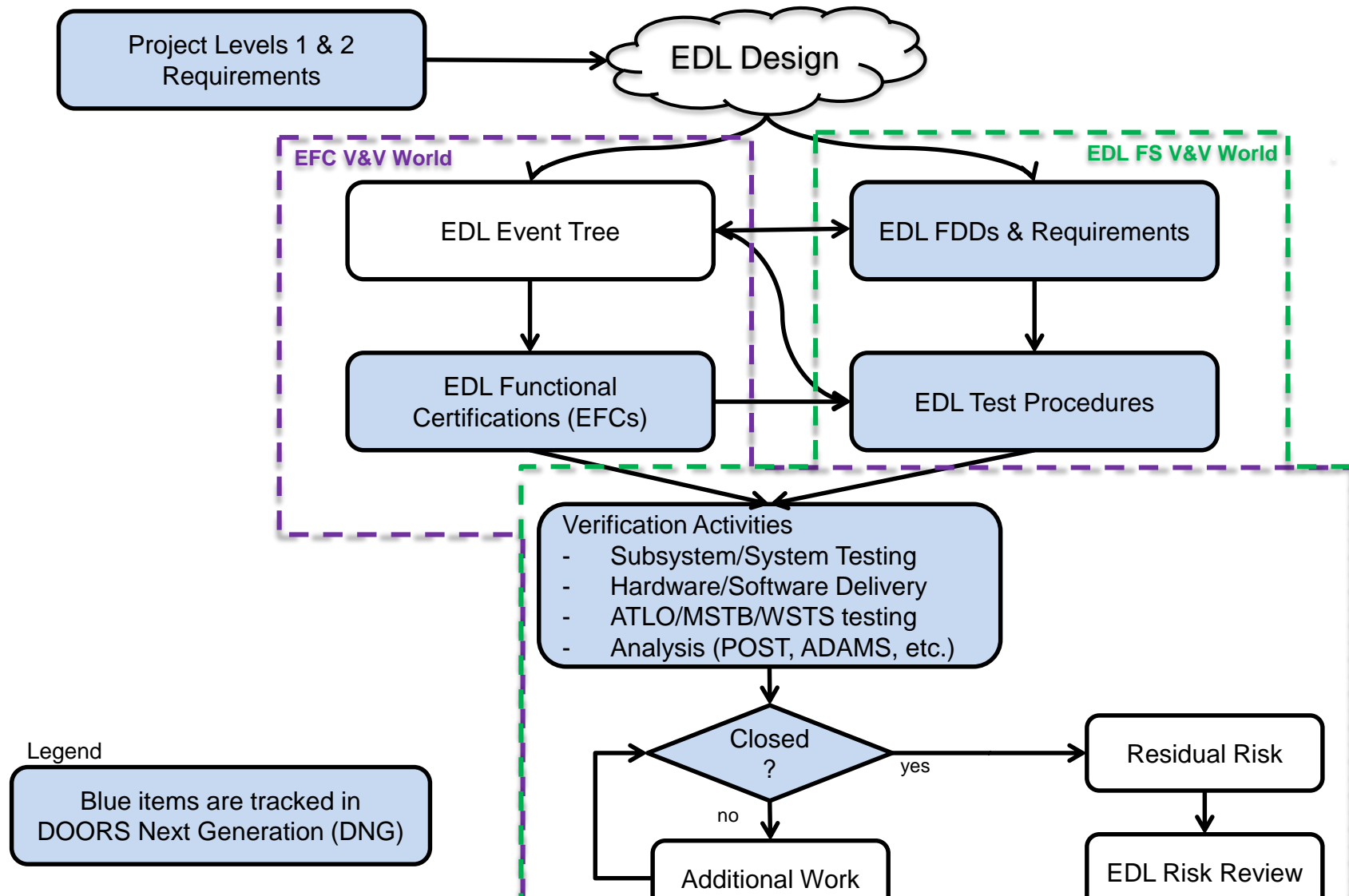
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It is easier to manage decoupled venues

EDL V&V Structure



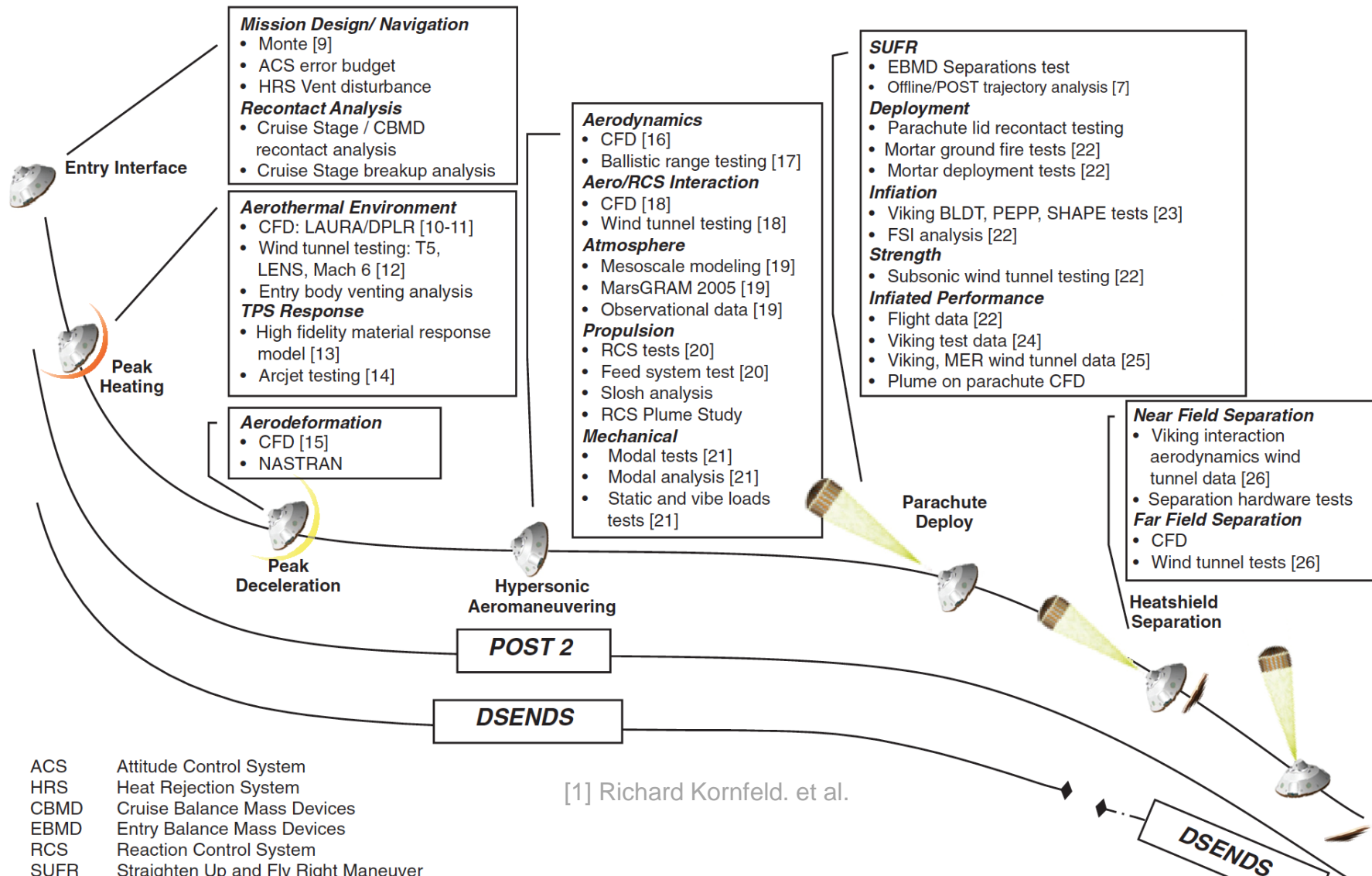
Requirements are not enough to V&V the EDL System.

EDL Event Tree

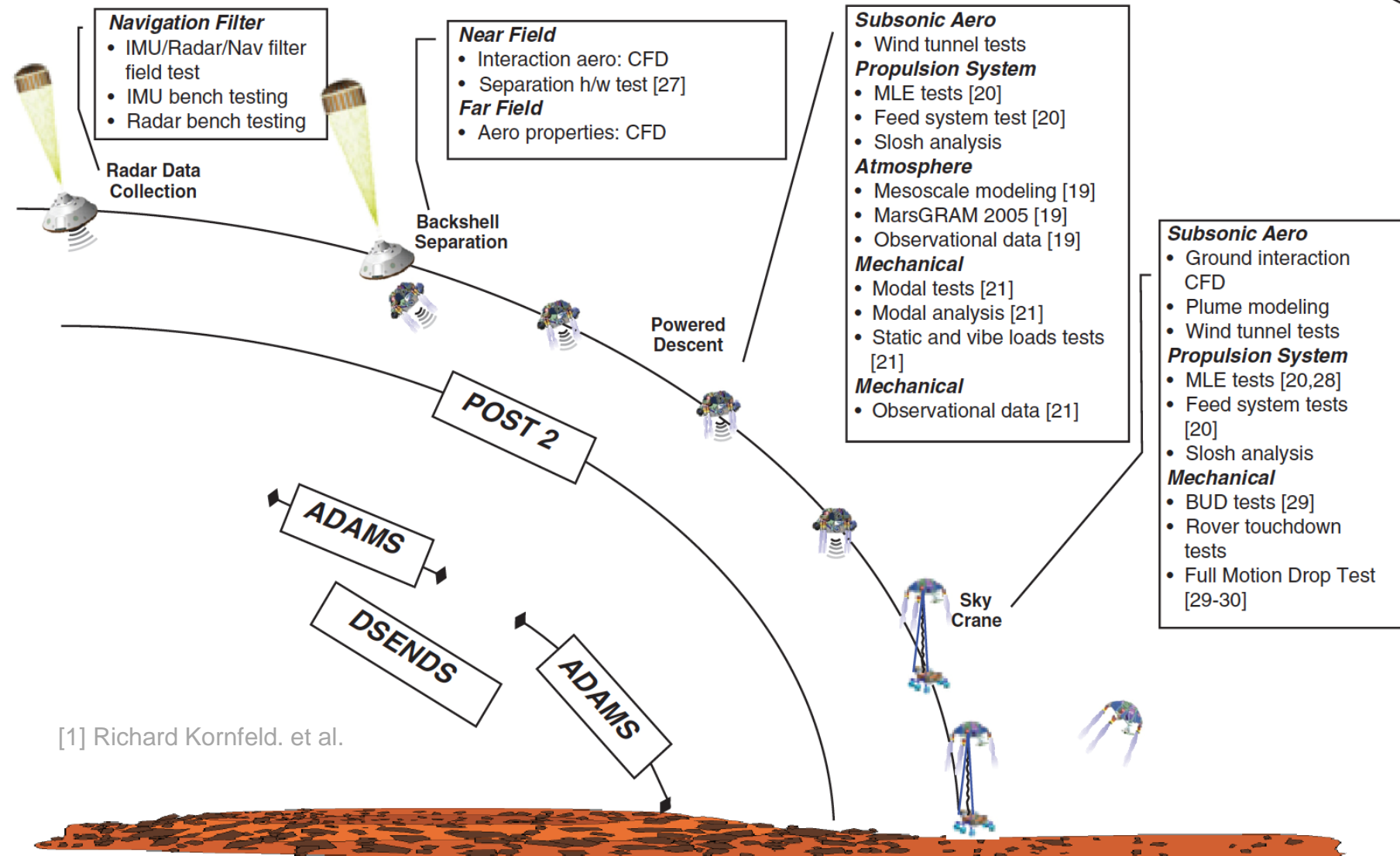


- Hierarchical method of enumerating all conditions and events that must be successfully executed to ensure EDL success
- Activities required to satisfy the nodes of the success tree are a superset of those that appear in a requirements-based V&V matrix
- All EDL requirements are mapped to Event Tree elements; not all elements can be associated with requirements

Element	Element Description	Study Number	Study Title	Study Owner	Relevant Requirement(s)
1000	•Final Approach Segment Successful	66	Final Approach Successful	Burkhart/Chen	
1001	•Segment Framework	66	Final Approach Successful	Burkhart/Chen	
1002	•Initial Conditions within System Capability	66	Final Approach Successful	Burkhart/Chen	
1003	•Initial Position and Velocity within Bounds	26	MDNAV Peer Review	Burkhart	FS-548
1004	•Spacecraft Attitude and Attitude Rates within Bounds	46	Cruise attitude	Collins	GNC-114
1005	•Flight System Healthy and in Correct Configuration	80	Flight System Healthy	Greco/Rozek	
1006	•Pre-EDL Nav Performs	30	Nav Filter Study	San Martin/Serrichio/Sell	
1007	•DIMU Calibration Successful	17	GNC alignment error budgets	San Martin/Essmiller	
1008	•Spacecraft Clock as Expected	57	Spacecraft clock verification	Krasner	I&T-288
1009	•Attitude Estimation is Correct	67	Entry Controller and Entry Guidance S	San Martin	
1010	•Nav Filter Processes Data Correctly	29	Nav Filter Study	San Martin/Serrichio/Sell	
1011	•DIMU Performs	12	DIMU Cert	San Martin	FS-910, GNC-20
1012	•DIMU Phasing is Correct	13	EDL FS VAG	Kornfeld	
1013	•DIMU-to-DSH Alignment & Stability is within Bounds	17	GNC alignment error budgets	San Martin/Essmiller	FS-720
1014	•Sensor Alignments Knowledge within Bounds at Launch	17	GNC alignment error budgets	San Martin/Essmiller	FS-285, 1146, 1147, 1153, 1151
1015	•DIMU-to-DSH Static deflection as Expected	17	GNC alignment error budgets	San Martin/Essmiller	MECH-110, 116
1018	•Attitude Propagator Performs	29	Nav Filter Study	San Martin/Serrichio/Sell	
1019	•Cruise Functionality Performs	93	Cruise Functionality	Portock	



Every segment has tests/analyses that are incorporated into the simulations



[1] Richard Kornfeld. et al.

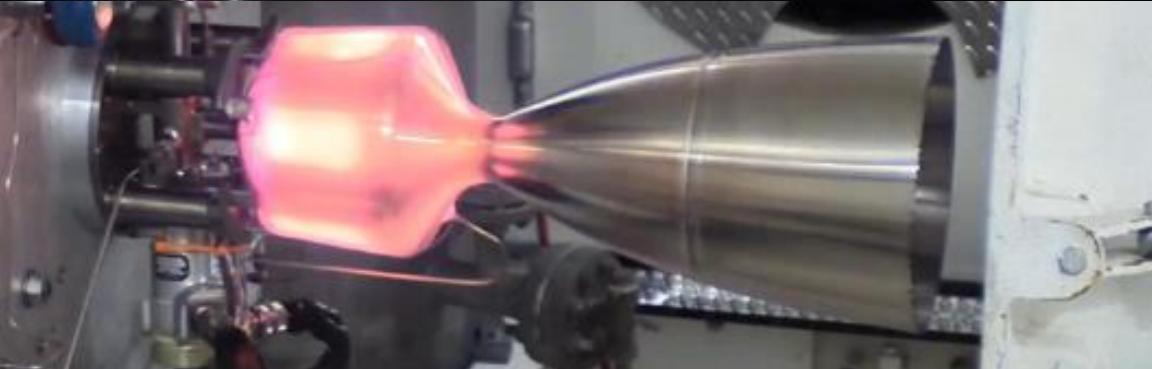
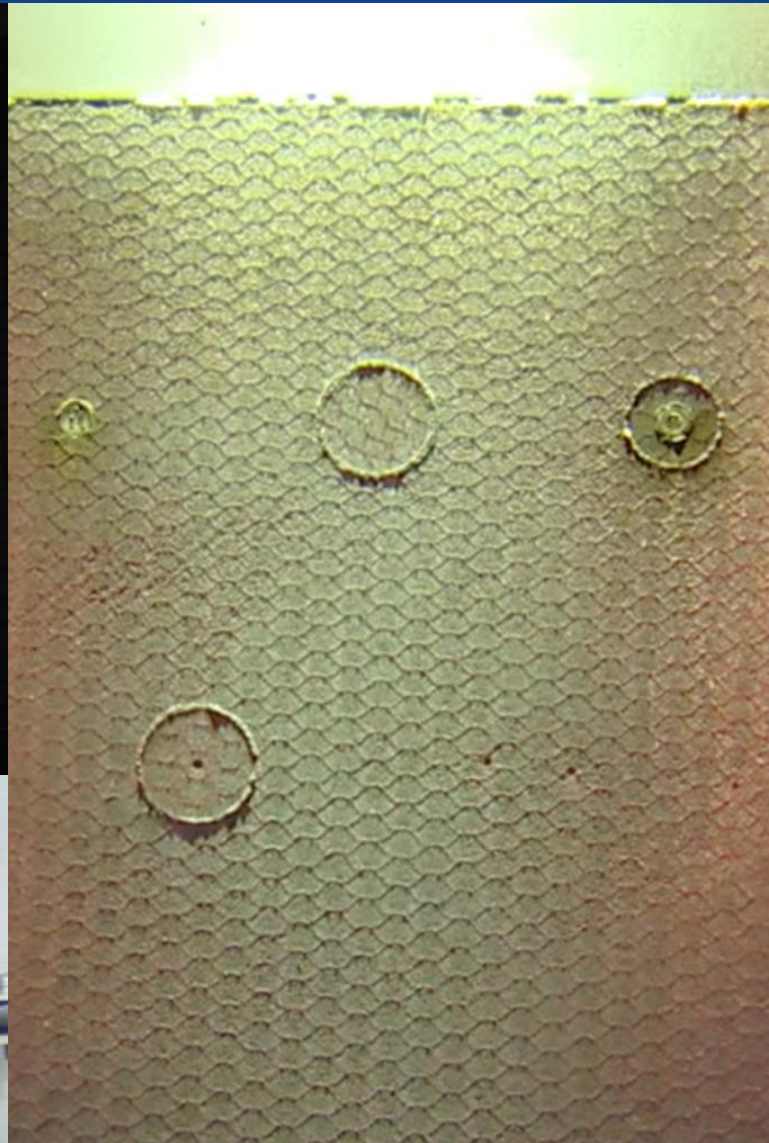
Independent validation is achieved using another simulation or analysis, where applicable

Subsystem



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Serves as lower-level V&V for EDL functions and model validation for simulations

Mission System



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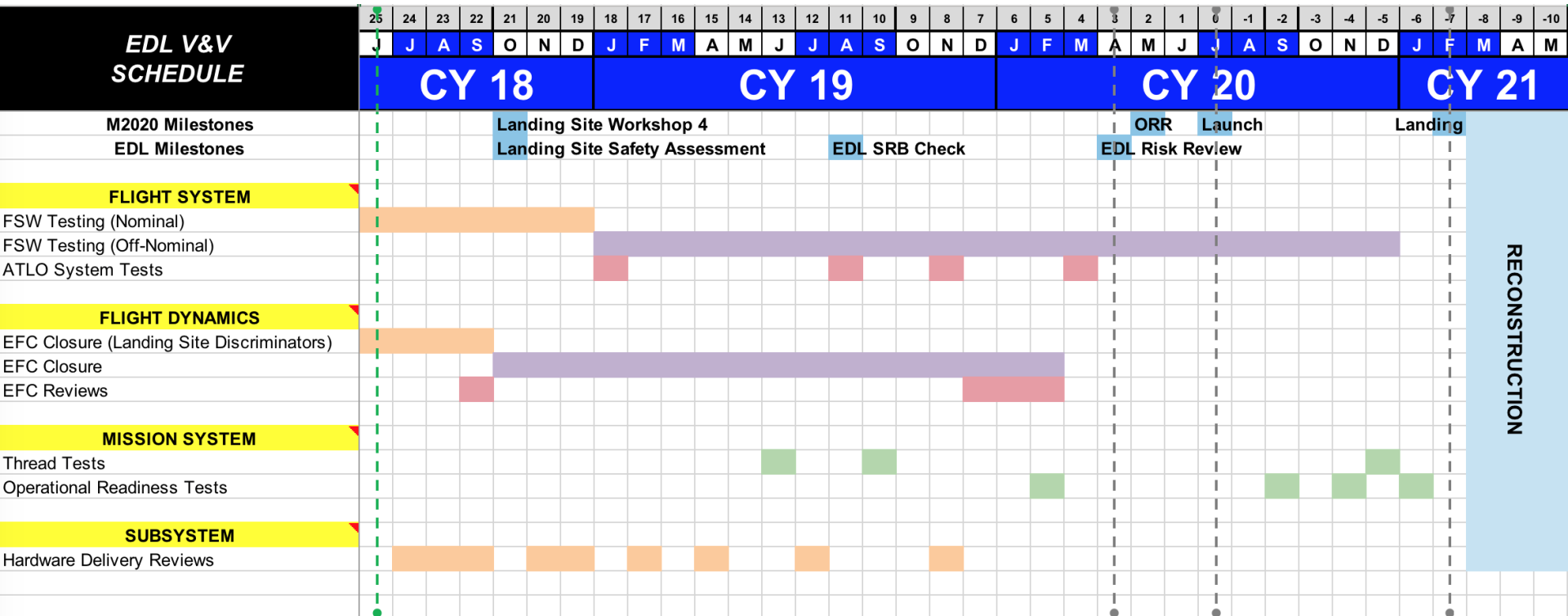
Flight activities leading up to EDL are executed in a short timeline, so the associated personnel, processes, and tools need to be exercised

EDL V&V Schedule

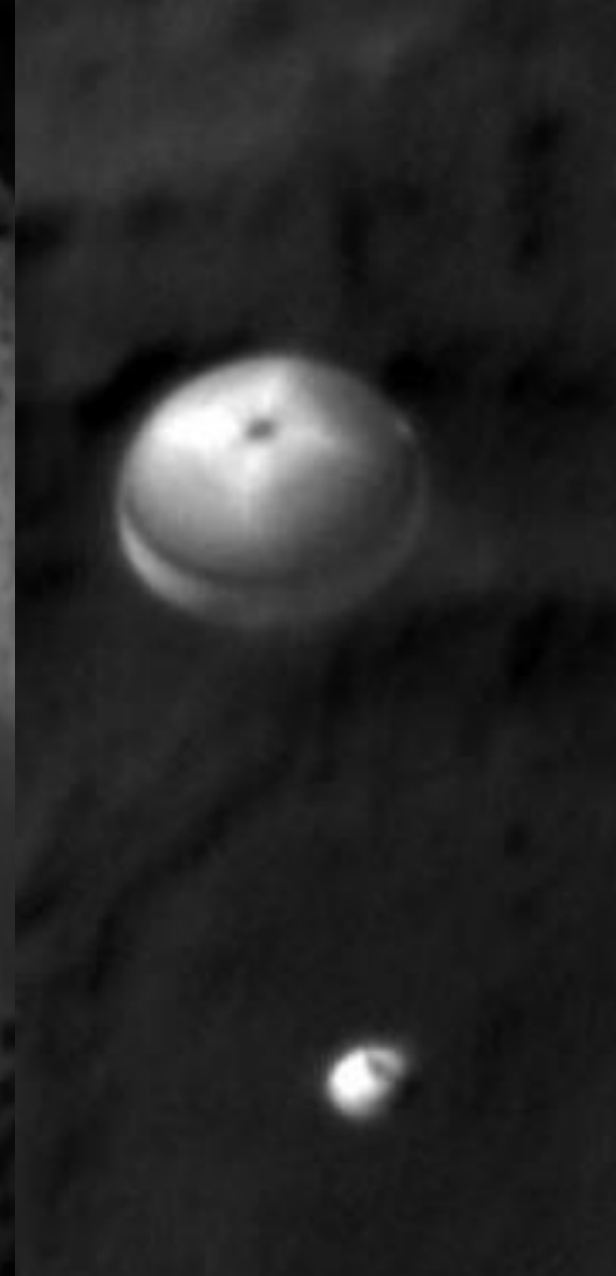


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There is more time to execute the Mars 2020 EDL V&V Program (compared to MSL), but it is being executed with a smaller team.



All essential components of Mars 2020 EDL V&V will be completed before launch in 2020, with additional flight software and operations testing extending until landing in 2021.